THE ENERGY STUDY ON THE UNIMAS FACULTY OF ENGINEERING BUILDINGS

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Universiti Malaysia Sarawak
2000

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This project report entitled "**THE ENERGY STUDY ON THE UNIMAS FACULTY OF ENGINEERING BUILDINGS**" was prepared by **HASLINA BINTI ABDUL RAHIM** as a partial fulfillment of the requirement for the degree of Bachelor of Engineering with honours (Mechanical Engineering and Manufacturing System) is hereby read and approved by:

Nazeri Abdul Rahman (Supervisor)	11 April 2000. Date

Dedicated to my beloved family

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" *BISMILLAHIRRAHMANIRRAHIM*"

IN THE NAME OF ALLAH MOST GRACIOUS,

MOST MERCIFUL

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ABSTRACT

The main objective was to study the energy usage in Faculty of Engineering office, Electronic and Telecommunication Engineering, and Civil Engineering building. The study is focusing in cooling or air-conditioning system. This study involved research and analysis, where inside and outside temperature were taken using Digital Thermometer (Thermoset). The relationship between the inside and outside temperature is determined through the knowledge of heat transfer. In addition, with these data different heat loss of material construction include concrete wall, wood (wall and door) and glass window was then be determined. The result of this study determined the energy usage in building much as of the air-conditioning system. The research is suggested recommendations for optimum energy usage and saving energy cost. The relationship obtained from this study is then used as a reference guide for the energy saving.

ABSTRAK

Objektif utama kajian ini adalah membincangkan penggunaan tenaga yang digunakan di dalam bangunan pejabat Fakulti Kejuruteraan dan makmal Kejuruteraan Elektronik dan Telekomunikasi dan Kejuruteraan sivil UNIMAS. Tumpuan utama kajian dalam sistem penyaman udara atau penyejukan ruang bilik. Kajian ini melibatkan kaji selidik dan analisis, dimana suhu dalam dan luar bangunan di ambil sebagai data kajian menggunakan Termometer Digital (Termoset). Penghubungan diantara suhu dalam dan luar bangunan dapat mengira dan menentukan pemindahan haba. Selain itu, dengan data-data yang diperolehi, pembezaan pemindahan haba antara bahan-bahan binaan bangunan yang merangkumi konkrit (dinding), kayu (dinding dan pintu) dan kaca (tingkap) dapat ditentukan. Keputusan kajian ini dapat menentukan penggunaan tenega di dalam bangunan banyak digunakan untuk proses penyejukan ruang. Penghubungan yang diperolehi daripada kajian ini dapat digunakan sebagai sumber rujukan kepada cara pengurangan dan penjimatan tenaga.

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NOMENCLATURES

A	Area of the components to heat flow [m^2]
A_c	Area of the Civil Engineering building [m^2]
A_{et}	Area of the Electronic and Telecommunication Engineering building [m^2]
A_o	Area of the Faculty of Engineering office building [m^2]
c_p	The specific heat of air at constant pressure [1.2 kg/m^3]
h_{ac}	The heat transfer coefficient for air [$W/m^2 K$]
h_c	The heat transfer coefficient from the surface to the fluid [$W/m^2 K$]
h_{ec}	The heat transfer coefficient for environment [$W/m^2 K$]
h_i	The heat transfer coefficient for inside room[$W/m^2 K$]
h_o	The heat transfer coefficient for outside [$W/m^2 K$]
k	The thermal conductivity of material [$W/m\ ^oC$ or $W/m\ K$]
n	The number of air changes per unit time [h^{-1}]
Q_F	The fabric heat loss [W]
Q_i	The input heat loss [W]
Q_o	The output heat loss [W]
Q_V	The ventilation heat loss [W]
R	The thermal resistance [$m^2 K/W$]
T_{AC}	The air conditioning temperature [K or ^oC]
T_{in}	The inside temperature [K or ^oC]
T_{out}	The outside temperature [K or ^oC]
U	The thermal transmittance [$W/m^2 K$]
V	The volume of building [m^3]

V_c The volume of Civil Engineering building [m^3]

V_{et} The volume of Electronic and Telecommunication Engineering building [m^3]

V_o The volume of Faculty of Engineering Office building [m^3]

x The component thickness [m]

x_c The component thickness of concrete wall [m]

x_d The component thickness of door [m]

x_g The component thickness of glass window [m]

x_w The component thickness of wooden wall [m]

GREEK LETTER

ΔT Temperature difference [K or ^oC]

ρ The density of air at constant pressure [1200 W s/m^3 K or (1/3) W h/m^3 K]

CHAPTER 1

INTRODUCTION

This chapter introduces the type of energy usage in building, history of energy and the energy usage in building.

1.1 Introduction to Energy

Energy is necessary for daily survival. It is one of the building blocks of modern life. It is also needed to create goods from natural resources and provide many of the services needed. Energy is defined as the capacity for producing an effect, which includes not only the physical work of moving heavy objects but also, it can be classified as stored energy or energy in transition **[Allen, 1992]**.

According to **Hinrichs [1992]**, the energy is the capacity of a physical system to do work; the units of energy are joules or ergs. While, the word work might bring various pictures to mind in such fields as literature and biology. In physics work is defined as the product of a force times a distance. Work is a way of transferring energy to an object. Another way of transferring energy to a system is through the flow of heat.

According to **Collins Cobuild English Dictionary [1995]**, energy is the power from sources such as electricity and coal that makes machines work or provides heat. Human being tends to take for granted the continuous availability of unlimited quantities of energy.

The internationally agreed unit for quantities of energy is Joule, and one Joule (1 J) of energy is required to make a force of one Newton (1 N) move through a distance of one meter (1m) **[Allen, 1992]**. The delivered energy is the available energy for consumer direct use in whatever manner is required - heating, lighting, mechanical work, cooking, transport and all kinds of industrial processes. Energy is needed to grow and process our food, manufacture, material possessions, warm and cool our building, transport us to work or for recreation.

Thermal energy is the sum of the kinetic energy, rotations energy and vibration energy of the molecules. Such energy tend to increase exponentially with time, this is show by **Figure 1.1**:

Daily per capita consumption of energy (1000 kilocalories)

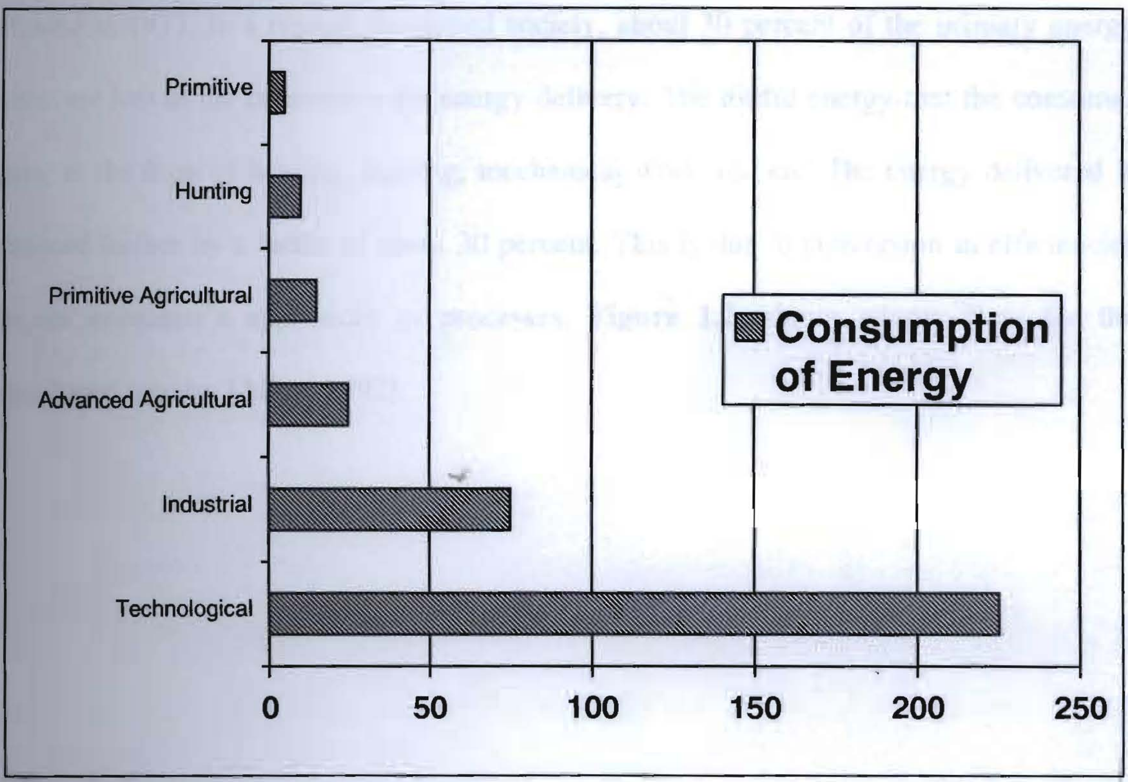

Figure 1.1 Consumption of energy in the development of human society [Allen, 1992].

1.2 History of Energy

Beginning with an oil embargo in 1973 and continuing through the Iranian revolution in 1979 made many people aware of how crucial the energy is to the everyday functioning of our society. Long gas lines and cold winters with natural gas shortages in the 1970s are still unhappy memories for some people. The energy crises of the 70s were almost forgotten in the 80s. However, the decade brought an increased awareness to our environment. Concerns with global warning, acid rain and radioactive waste are still with us today and each of these is related to our usage in energy. The interest in energy has been rekindled in the 1990s, again because of political events in the Middle East **[Hinrichs, 1992]**.

The federal department responsible for maintaining a national energy policy created in 1977. In a typical developed society, about 30 percent of the primary energy input are lost in the conversion for energy delivery. The useful energy that the consumer gets, in the form of heating, lighting, mechanical work and etc. The energy delivered is reduced further by a factor of about 30 percent. This is due to conversion in efficiencies in the consumer's appliances or processes. **Figure 1.2**, shows energy flow for the developed country **[Allen, 1992]**:

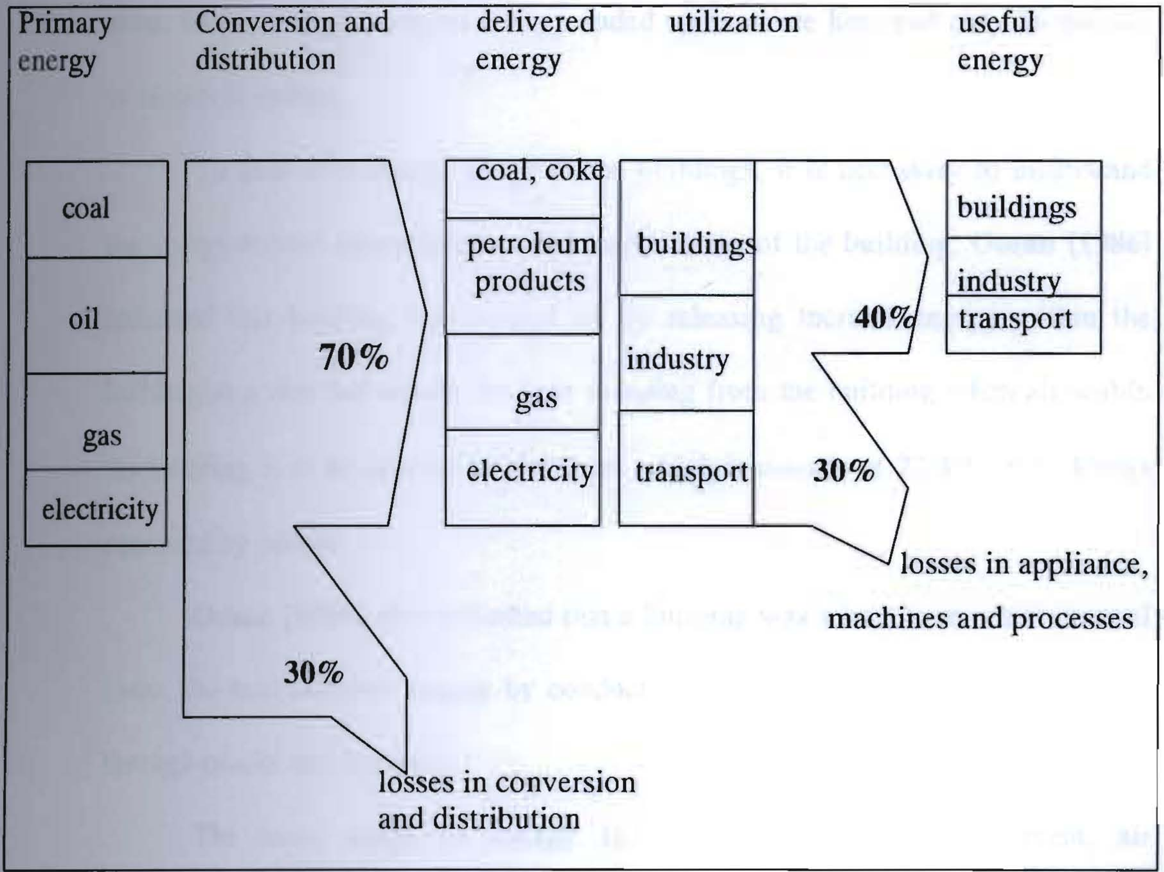

Figure 1.2 Energy flow through developed country [Allen, 1992].

1.3 Introduction to Energy in Building

1.3.1 Energy in Building

The uses of energy are traditionally broken down into four sectors, commercial building (offices, schools, hospital), industrial, transportation and residential (single-family and multi-family dwellings). The quality of energy is degraded in transformation and its usefulness for performing work is reduced. It is impossible to convert all of a given quantity of heat energy into useful work, as a significant proportion of it is always discharged to the surroundings. According to **Hinrichs [1991]**, the amount of wasted heat was about half of the energy input. The largest percentage of waste occurred in the generation of electricity, where about 64 percent of the input energy ended up as waste heat and only 36 percent as electrical energy.

To deal with energy usage in the buildings, it is necessary to understand the energy-related characteristics and implications of the building. **Oman [1986]** indicated that building was heated up by releasing thermal energy within the building at a rate that equals the heat escaping from the building when air within the building is at its desired temperature, which is usually at 22.4°C in buildings occupied by people.

Oman [1986] also indicated that a building was a box from which in cool room, the heat lost was mostly by conduction through walls and in air that leaks through cracks and opening.

The main usage of energy in the building is the equipment, air conditioning and lighting. Conditions within the building are determined by the type of equipment used, the number of people, the type of activity, water vapour generated and process used. Any scheme for improving energy efficiency in buildings must begin with space heating. The means will vary from building to building depending on their size, age, and state of repair and the uses to which they are put in used.

By following the standard imposed by **Baharudin [1989]**, room temperature in Malaysia's building must be at least 25.5°C, but the room temperature usually set between 22°C to 18°C.

Baharudin [1989] indicated that, estimated that 55 percent of the energy used in buildings is for air conditioning, 32 percent for lighting and 13 percent for equipment. This is showed by **Figure 1.3.**

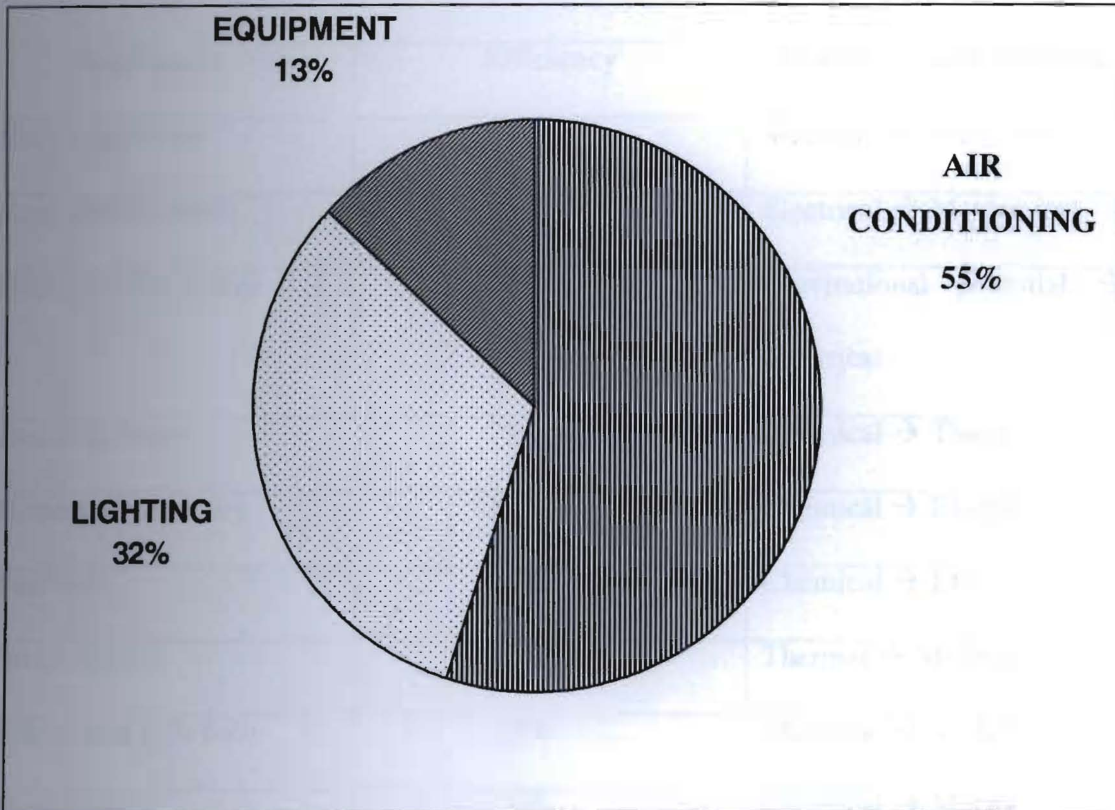

Figure 1.3 Energy used in building [Baharuddin, 1989].

1.3.2 Heat Loss and Heat Gain

Heat is a form of energy produced through the expenditure of another form of energy. Heat is defined as a form of energy that is transferred across the boundaries of a system due to the difference in temperature.

Energy transformation vary considerably in it degree of efficiency but it remains the ever-present tendency for some energy to be lost to the environment. **Allen [1992]** indicated that an ordinary electric light bulb is a familiar household object in which only about 5 percent of the electrical energy input appears as light, the remaining 95 percent going to heat up the surroundings. The relative efficiencies of a number of common energy converting devices are illustrated in **Table 1.1**.